

Weekly integrated bulk total aerosol trace element concentrations from the Hawaii Aerosol Time-series during January 2022 to October 2023

Website: <https://www.bco-dmo.org/dataset/986789>

Data Type: Other Field Results

Version: 1

Version Date: 2025-12-03

Project

» [Hawaii Aerosol Time-Series \(HATS\):Quantifying Marine Dust Deposition and Composition in an Oligotrophic Gyre \(HATS\)](#)

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Abstract

This study aimed to quantify seasonal aerosol trace element fluxes and evaluate their variability and potential sources over a two-year period in the North Pacific subtropical gyre (NPSG). We established the Hawaii Aerosol Time Series (HATS), a sampling program at Makai Research Pier on O'ahu (21.32° N, 157.67° W), to collect weekly-integrated total suspended particle samples. Sampling was sector-controlled to collect when winds were onshore at a velocity of greater than 0.5 meters per second (m/s). The sampler was fitted with a GEOTRACES-style, custom-made manifold holding 12 acid-washed, 47-millimeter (mm) diameter Whatman-41 filters. Three filters were reserved for total digestion. The digestion procedure is a three-step process where the samples were sequentially acidified with concentrated double-distilled nitric acid, hydrofluoric acid, and hydrogen peroxide, heated to ~140 degrees Celsius (°C) on a hotplate overnight, and then taken to near dryness. Following the final dry-down, samples were brought up in 0.32 M optima HNO₃ and then analyzed for a mix of primarily lithogenic and anthropogenically associated trace elements (including Al, Co, Cr, Cu, Fe, Mn, Ni, Pb, Ti, V, and Zn) via quadrupole inductively coupled plasma mass spectrometry (ICP-MS).

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Coverage

Location: North Pacific Ocean

Spatial Extent: Lat:21.32 Lon:-157.67

Temporal Extent: 2022-01-06 - 2023-10-26

Methods & Sampling

A high-volume total suspended particle aerosol sampler (Tisch Environmental TE-5170V-BL), installed at Makai Research Pier (21.32° N, 157.67° W) on the eastern side of O'ahu, collected weekly-integrated bulk aerosol samples from January 2022 to October 2023. Makai Research Pier experiences regular northeasterly winds, which were isolated with a sector-control system that powered the sampler during onshore wind conditions at a velocity >0.5 meters per second (m/s). The sampler was fitted with a GEOTRACES-style, custom-made manifold holding 12 acid-washed, 47-millimeter (mm) diameter Whatman-41 filters (e.g. Buck et al., 2019). Filters were acid washed before use to reduce trace element blanks. Sample filters were stored individually in plastic Petri slides at -20 degrees Celsius (°C) until transport to Skidaway Institute of Oceanography for processing and analysis.

Of the 12 filters collected with the aerosol sampler, three filters were reserved for total digestion. The digestion procedure is a three-step process (full details described in Marsay et al., 2022) where the samples were sequentially acidified with concentrated double-distilled nitric acid ($d\text{-HNO}_3$), hydrofluoric acid (Fisher Trace Metal Grade; HF), and hydrogen peroxide (Fisher Optima Grade; H_2O_2), heated to ~140 °C on a hotplate overnight, and then taken to near dryness. A known volume of Rh was added to the first acid-addition step to account for any potential loss of material over the course of the digestion process. Following the final dry-down, samples were brought up in 0.32 M optima HNO_3 and then analyzed for a mix of primarily lithogenic and anthropogenically associated trace elements (including Al, Co, Cr, Cu, Fe, Mn, Ni, Pb, Ti, V, and Zn) via quadrupole ICP-MS (Perkin Elmer Nexion 300D). The instrument was operated in standard mode for Al and Ti and reaction gas mode (NH_3) for the remaining elements to reduce polyatomic interferences. The Standard Reference Material NIST 1643f was analyzed with the analytical run to evaluate instrument performance. Filter blanks were digested, analyzed, and subtracted from sample values to correct for any external contributions, while reference materials (Arizona Test Dust and MESS-3) were also processed and analyzed to assess the efficiency of the digestion procedure. Finally, the bulk trace element aerosol concentrations were normalized by dividing the filter concentrations by the volume of air sampled during each respective deployment.

Data Processing Description

All data processing was completed using Microsoft Excel.

Note on detection limits: 700 cubic meters was used to calculate representative detection limits.

Note on concentration averages: Averages are of 3 independent filter sample digestions, except when values were excluded because:

- (a) a value was lower than 3x standard deviation of filter blank;
- (b) a value was determined to be a statistical outlier by Grubbs' test.

Quality Flag Codes:

BDL = below detection limit

0 = No QC performed

1 = Good data

2 = Probably good data

3 = Probably bad data that is potentially correctable

4 = Bad data

5 = Value changed

6 = Sample < blank

8 = Interpolated value

9 = Missing value

BCO-DMO Processing Description

- Imported original file "HATS Total Aerosols.csv" into the BCO-DMO system.
- Created ISO 8601 date-time columns.
- Added columns for site latitude and longitude.
- Renamed fields to comply with BCO-DMO naming conventions
- Saved the final file as "986789_v1_hat_total_aerosols.csv".

Data Files

File
986789_v1_hat_total_aerosols.csv (Comma Separated Values (.csv), 18.28 KB) MD5:cfb0f2df9d228fc195b0fb7a385a4f75
Primary data file for dataset ID 986789, version 1

Related Publications

Buck, C. S., Aguilar-Islas, A., Marsay, C., Kadko, D., & Landing, W. M. (2019). Trace element concentrations, elemental ratios, and enrichment factors observed in aerosol samples collected during the US GEOTRACES eastern Pacific Ocean transect (GP16). *Chemical Geology*, 511, 212–224.

<https://doi.org/10.1016/j.chemgeo.2019.01.002>

Methods

Marsay, C. M., Kadko, D., Landing, W. M., & Buck, C. S. (2022). Bulk Aerosol Trace Element Concentrations and Deposition Fluxes During the U.S. GEOTRACES GP15 Pacific Meridional Transect. *Global Biogeochemical Cycles*, 36(2). Portico. <https://doi.org/10.1029/2021gb007122>

Methods

Related Datasets

IsRelatedTo

Ricci, M., Ohnemus, D. C. (2025) **Size fractionated particulate trace metal concentrations from in-situ filtration near Station ALOHA during four R/V Kilo Moana cruises between August 2022 and August 2023**. Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2025-10-15 <http://lod.bco-dmo.org/id/dataset/987161> [[view at BCO-DMO](#)]

Parameters

Parameter	Description	Units
Deployment	Aerosol deployment number	unitless
Latitude	Latitude of sampler location	decimal degrees
Longitude	Longitude of sampler location	decimal degrees
Julian_Day	Sampling start Julian day	unitless
Start_ISO_DateTime_UTC	Date and time (UTC) of sampling start in ISO 8601 format	unitless

Start_Day	Sampling start day	unitless
Start_Month	Sampling start month	unitless
Start_Year	Sampling start year	unitless
Start_Time_UTC	Sampling start time (UTC)	unitless
End_ISO_DateTime_UTC	Date and time (UTC) of sampling end in ISO 8601 format	unitless
End_Day	Sampling end day	unitless
End_Month	Sampling end month	unitless
End_Year	Sampling end year	unitless
End_Time_UTC	Sampling end time (UTC)	unitless
Air_Vol_Total	Total volume of air sampled	cubic meters (m3)
Al_A_T_AVG_HIVOL	Total particulate aerosol Al concentration, average. Detection limit = 9.4	picomoles per cubic meter (pmol/m3)
Al_A_T_STDEV_HIVOL	Total particulate aerosol Al concentration, standard deviation	picomoles per cubic meter (pmol/m3)
Al_A_T_QF_HIVOL	Total particulate aerosol Al concentration, data quality flag (see metadata for definitions)	picomoles per cubic meter (pmol/m3)
Ti_A_T_AVG_HIVOL	Total particulate aerosol Ti concentration, average. Detection limit = 2.8	picomoles per cubic meter (pmol/m3)
Ti_A_T_STDEV_HIVOL	Total particulate aerosol Ti concentration, standard deviation	picomoles per cubic meter (pmol/m3)
Ti_A_T_QF_HIVOL	Total particulate aerosol Ti concentration, data quality flag (see metadata for definitions)	picomoles per cubic meter (pmol/m3)
V_A_T_AVG_HIVOL	Total particulate aerosol V concentration, average. Detection limit = 0.19	picomoles per cubic meter (pmol/m3)

V_A_T_STDEV_HIVOL	Total particulate aerosol V concentration, standard deviation	picomoles per cubic meter (pmol/m3)
V_A_T_QF_HIVOL	Total particulate aerosol V concentration, data quality flag (see metadata for definitions)	picomoles per cubic meter (pmol/m3)
Cr_A_T_AVG_HIVOL	Total particulate aerosol Cr concentration, average. Detection limit = 0.36	picomoles per cubic meter (pmol/m3)
Cr_A_T_STDEV_HIVOL	Total particulate aerosol Cr concentration, standard deviation	picomoles per cubic meter (pmol/m3)
Cr_A_T_QF_HIVOL	Total particulate aerosol Cr concentration, data quality flag (see metadata for definitions)	picomoles per cubic meter (pmol/m3)
Mn_A_T_AVG_HIVOL	Total particulate aerosol Mn concentration, average. Detection limit = 0.03	picomoles per cubic meter (pmol/m3)
Mn_A_T_STDEV_HIVOL	Total particulate aerosol Mn concentration, standard deviation	picomoles per cubic meter (pmol/m3)
Mn_A_T_QF_HIVOL	Total particulate aerosol Mn concentration, data quality flag (see metadata for definitions)	picomoles per cubic meter (pmol/m3)
Fe_A_T_AVG_HIVOL	Total particulate aerosol Fe concentration, average. Detection limit = 2	picomoles per cubic meter (pmol/m3)
Fe_A_T_STDEV_HIVOL	Total particulate aerosol Fe concentration, standard deviation	picomoles per cubic meter (pmol/m3)
Fe_A_T_QF_HIVOL	Total particulate aerosol Fe concentration, data quality flag (see metadata for definitions)	picomoles per cubic meter (pmol/m3)
Co_A_T_AVG_HIVOL	Total particulate aerosol Co concentration, average. Detection limit = 0.035	picomoles per cubic meter (pmol/m3)
Co_A_T_STDEV_HIVOL	Total particulate aerosol Co concentration, standard deviation	picomoles per cubic meter (pmol/m3)
Co_A_T_QF_HIVOL	Total particulate aerosol Co concentration, data quality flag (see metadata for definitions)	picomoles per cubic meter (pmol/m3)
Ni_A_T_AVG_HIVOL	Total particulate aerosol Ni concentration, average. Detection limit = 0.062	picomoles per cubic meter (pmol/m3)

Ni_A_T_STDEV_HIVOL	Total particulate aerosol Ni concentration, standard deviation	picomoles per cubic meter (pmol/m3)
Ni_A_T_QF_HIVOL	Total particulate aerosol Ni concentration, data quality flag (see metadata for definitions)	picomoles per cubic meter (pmol/m3)
Cu_A_T_AVG_HIVOL	Total particulate aerosol Cu concentration, average. Detection limit = 0.34	picomoles per cubic meter (pmol/m3)
Cu_A_T_STDEV_HIVOL	Total particulate aerosol Cu concentration, standard deviation	picomoles per cubic meter (pmol/m3)
Cu_A_T_QF_HIVOL	Total particulate aerosol Cu concentration, data quality flag (see metadata for definitions)	picomoles per cubic meter (pmol/m3)
Zn_A_T_AVG_HIVOL	Total particulate aerosol Zn concentration, average. Detection limit = 0.98	picomoles per cubic meter (pmol/m3)
Zn_A_T_STDEV_HIVOL	Total particulate aerosol Zn concentration, standard deviation	picomoles per cubic meter (pmol/m3)
Zn_A_T_QF_HIVOL	Total particulate aerosol Zn concentration, data quality flag (see metadata for definitions)	picomoles per cubic meter (pmol/m3)
Pb_A_T_AVG_HIVOL	Total particulate aerosol Pb concentration, average. Detection limit = 0.00029	picomoles per cubic meter (pmol/m3)
Pb_A_T_STDEV_HIVOL	Total particulate aerosol Pb concentration, standard deviation	picomoles per cubic meter (pmol/m3)
Pb_A_T_QF_HIVOL	Total particulate aerosol Pb concentration, data quality flag (see metadata for definitions)	picomoles per cubic meter (pmol/m3)

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Instruments

Dataset-specific Instrument Name	Tisch Environmental TE-5170V-BL
Generic Instrument Name	Aerosol Sampler
Dataset-specific Description	High-volume total suspended particle aerosol sampler. Flow rate = 1 m ³ /min.
Generic Instrument Description	A device that collects a sample of aerosol (dry particles or liquid droplets) from the atmosphere.

Dataset-specific Instrument Name	Perkin Elmer Nexion 300d
Generic Instrument Name	Inductively Coupled Plasma Mass Spectrometer
Dataset-specific Description	Perkin Elmer Nexion 300d quadrupole inductively coupled plasma mass spectrometer
Generic Instrument Description	An ICP Mass Spec is an instrument that passes nebulized samples into an inductively-coupled gas plasma (8-10000 K) where they are atomized and ionized. Ions of specific mass-to-charge ratios are quantified in a quadrupole mass spectrometer.

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Project Information

Hawaii Aerosol Time-Series (HATS):Quantifying Marine Dust Deposition and Composition in an Oligotrophic Gyre (HATS)

Coverage: Hawaii

NSF Award Abstract:

The chemistry of the ocean can be changed by the introduction and removal of elements, including trace elements which are present at low concentrations. In some cases, these elements are known to be vital to biological processes and ocean food webs. Near the shore, rivers are a large source for material from land to the ocean. Beyond the reach of rivers, and for most of the oceans, material blown from land through the air is the largest source of trace elements to surface waters. This material enters the oceans dissolved in rain or by settling of dust particles. Understanding atmospheric sources of trace elements to the oceans is thus important to understanding both global chemical cycles and patterns of biological production. This project will sample the atmosphere and the surface ocean near Hawaii over two years to gain a deeper understanding of the sources and fates of trace metals in the ocean. The study will examine how particles from the atmosphere interact with the surrounding water as they sink through the ocean. The project will contribute to global synthesis and modeling efforts. It will directly support graduate and undergraduate students. Results of the project and their relevance will be communicated to the public through campus open house events and a public lecture series.

The processes that supply and remove trace elements in the ocean are ongoing areas of research. An important focus is on understanding the sources and fate of aerosol trace elements deposited to the ocean as this represents a major source of micronutrients and contaminants into the open ocean. Field observations of wet and dry atmospheric inputs are limited in number, and few methods are available to transform readily measured aerosol trace element concentrations into deposition fluxes. Thus, atmospheric fluxes of trace elements to most ocean regions remain poorly constrained and their impact on ocean biochemical cycles, including the marine carbon cycle, are uncertain. Directly quantifying atmospheric fluxes of key trace elements to the ocean and identifying their fates and chemical transformations after deposition are critical areas of continued investigation and are included, for example, as a core component of the GEOTRACES program. Similarly, aerosol fractional solubility and the flux of bioavailable trace elements is not well understood. There is

a corresponding need to test and improve estimates of total dust deposition fluxes alongside simultaneous observations of particle composition in the open ocean. This project will address these needs through a two-year land-based sampling effort and six seasonal cruises aimed at three tasks. (1) Use the deposition flux of beryllium-7 measured from aerosols, precipitation, and the upper ocean inventory to directly estimate dust and aerosol trace element fluxes to the Hawaii Ocean Time-series Station Aloha, a representative and remote oligotrophic site. This region is characterized by a predictable seasonal variability in dust concentrations and precipitation and is an exceptionally applicable region for testing the limits of dust deposition techniques by observing seasonal variability in ocean-atmosphere coupling over a multi-year cycle. (2) Explore the extent to which seasonal variations in aerosol trace element flux to the surface of the North Pacific, and mineralogy of that input drive variability in the composition and inventories of marine particles. (3) Investigate the extent to which the fractional solubility of aerosol trace elements collected over the North Pacific shows temporal variability and calculate flux rates of soluble aerosol trace elements. The study will advance understanding of dust and soluble aerosol trace element flux from the atmosphere to the ocean and link that flux to upper ocean particle inventory, mineralogy, and chemical composition.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1949660

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